



ATO-P R&D

Human Factors Research and Engineering Division

Human Factors Newsletter # 06-12

June 3, 2006 – June 16, 2006

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Technical Note: Ahlstrom, U. & Friedman-Berg, F. J. (2006). *Controller Scan Path Behavior during Severe Weather Avoidance* (DOT/FAA/TC- 06/07). Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center.

Executive Summary

Information displays are currently used in many new areas including the presentation of aviation and air traffic control (ATC) related weather information (Ahlstrom & Della Rocco, 2003). Although weather visualizations have a long tradition in meteorology and weather forecasting, much less is known about how to create efficient weather displays for ATC operations. In current ATC operations, traffic management and supervisors use weather information primarily for planning purposes. Their aim is to grasp the big weather picture, identify important trends and patterns, and use this information to plan future actions. However, controllers use weather information in an environment where the focus is on tactical thinking. Therefore, they need tactical weather tools to make safe and efficient decisions that support the hands-on, moment-to-

moment management of air traffic within the airspace (Ahlstrom, 2005). The question is what type of temporal format (static versus dynamic) and display representation (text versus graphics) produces the most efficient design for use in tactical operations.

Eye movement guidance on information displays is an active process of exploring display regions for goal-relevant information. Therefore, we might use eye movement analysis as an objective method for assessing the location of meaningful content in an information display. In the present study, we examined controllers' fixation behavior on Storm Motion tools during severe weather avoidance. The data consisted of eye movement recordings from time intervals when controllers activated a static or a dynamic Storm Motion tool. Both of these tools provided information about the direction of storm cell motion and future extrapolated positions of the storm cell leading edge. By analyzing the location and extent of fixations, we performed an assessment to identify the static weather tool features that captured controllers' visual attention (i.e., areas of visual interest). Second, we analyzed controller scan path behavior (a series of fixations and saccades) while they were using the static and the dynamic tools. Third, we assessed controller fixation prioritization strategies during static tool usage.

Our results showed that controllers focused their visual attention significantly more on the area between the storm cell leading edge and the 10 minute extrapolated position compared to other areas of the static Storm Motion tool. With regards to controller scan paths, we found that dynamic Storm Motion tools significantly reduced controller scan path areas, scan path distances, and scan path durations compared to the static tool. Furthermore, the mean pupil diameter was significantly smaller for controllers while using the dynamic tool compared to the static tool, indicating a lower visual and cognitive workload during the dynamic condition. We found little evidence for systematic controller fixation behavior while they were using the static tool. The few systematic patterns that we revealed were two-step fixation patterns (e.g., aircraft → 10 minute extrapolated position), and the vast majority of fixation orders (patterns) were unique to each individual controller.

In our static Storm Motion display, the activation caused the appearance of tool features on storm cells throughout the display. This abrupt onset captured controllers' attention and resulted in significantly larger scan path areas, scan path distances, and scan path durations compared to when controllers were using the dynamic tool. Furthermore, controllers had significantly larger pupil diameters when using static tools compared to dynamic tools, which is indicative of higher visual and cognitive workload (Van Orden, Limbert, Makeig, & Jung, 2001). Therefore, rather than facilitating and enhancing controller scan path behavior, the static tool interrupted goal-directed exploration and produced less efficient scan path behavior. We hypothesize that the static tool may have less negative effect on scan path behavior if it is displayed in smaller areas on the situation display. For example, rather than displaying all available Storm Motion information on cells throughout the situation display, it should be possible to define and tailor the presentation of this information to cover smaller, but more relevant areas. Furthermore, by only displaying elements that define the area between the storm cell leading edge and the 10 minute extrapolated position, it might be possible to enhance controller information pick-up during tactical operations even further while reducing attentional capture.

We conclude, given what we know now, that animated storm predictions are more suitable for tactical ATC operations, as compared to static element-based representations. By using this

display principle when designing future Storm Motion displays, we should be able to create weather tools that increase controller efficiency and safety during weather avoidance in tactical ATC.

This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 3: Increase on-time performance of scheduled carriers.

Point of Contact: U. Ahlstrom , WJHTC

Technical Note: Stein, E. S., Della Rocco, P. S., & Sollenberger, R. L. (2006). *Dynamic Resectorization in Air Traffic Control: A Human Factors Perspective* (DOT/FAA/TC-TN06/19). Atlantic City International Airport, NJ: Federal Aviation Administration William J. Hughes Technical Center.

Abstract

The National Airspace System is a highly structured environment. Structure provides benefits including predictability for the decision-maker, the air traffic controller. When something is unusual, controllers can identify the event as out of the ordinary, given their inherent and trained capacity for pattern recognition. The expertise in pattern recognition does not develop quickly.

In the current system, it takes en route controllers an average of about three years to certify as Certified Professional Controllers (CPCs, formerly Full Performance Level). In general, CPCs must learn and check out on at least six different sectors to certify. There are situations, however, when the usual structure is reduced and the typical patterns do not work. This can happen with weather events and systems outages as examples. Dynamic resectorization offers a tool in these situations to increase the options and promote flexibility. In our current system, traffic managers can resectorize in a very systematic, structured way to balance the load and increase the level of structure for controllers. The system of the future may include several types of resectorization supported by automation tools. Limited dynamic resectorization is similar to what is done now, but may see more widespread use. Unlimited dynamic resectorization represents a leap into the future with underlying technology that does not exist today. Both approaches raise human factors questions, which should be approached systematically in a proactive manner. The more flexible the system becomes, the more dynamic the options will be. Operators will need solid anchors if they are going to be able to efficiently and expeditiously maintain safe separation between aircraft.

This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 3: Increase on-time performance of scheduled carriers.

Point of Contact: E. Stein, WJHTC

Safety Culture Seminar: A seminar entitled "Toward a Safer Culture," sponsored by ATO-P Human Factors Research and Engineering Division, will be presented by Dr. Manoj Patankar (Saint Louis University), on Wednesday, June 28, 2006, from 9:00 a.m. to 12:00 p.m. The purpose of the seminar is to provide participants a working understanding of Safety Culture—

what is it, its significance, how to measure the current status, what/how to change, how to measure the change, and how to institutionalize the change. This is a three-hour module presented in conjunction with other human factors technical workshops and seminars. It provides an overview of the principles of a safety culture, how to apply them in an operational setting, and how to measure the results. This seminar provides a tutorial on safety culture theory, key parameters, actionable means to implement, behaviors and methods to improve performance, qualitative and quantitative measures and assessment techniques, and reporting. *This activity supports the Administrator's Flight Plan Goal for Organizational Effectiveness, Objective 1: Make the organization more effective with stronger leadership, increased commitment of individual workers to fulfill organization-wide goals, and a better prepared, better trained, safer, diverse workforce.* (Glen Hewitt, ATO-P R&D)

Air Traffic Selection and Training: On June 5-8, 2006, Dr. Ray King traveled to the Defense Manpower Data Center in Monterey, California to exchange information with the Military Accession Policy Working Group in preparation for further collaborative research efforts. He presented subtests of the Air Traffic Selection and Training (AT-SAT) battery to the assembled researchers, as they are interested in methods to add incremental validity to the Armed Services Vocational Aptitude Battery composite that is currently being used to select military enlisted members into the air traffic career field. The military services have been struggling with increasing attrition from air traffic control training, and are interested in stemming the tide. They plan to conduct a comparative study of components of the two methods using data from Army, Air Force and Navy participation (over 1000 air traffic control students) in the AT-SAT Parallel Forms Equating Study. The services have outcome measures available, enhancing the value of such a comparative study to both the DoD and the FAA. *This activity supports the Administrator's Flight Plan Goal for Organizational Effectiveness, Objective 1: Make the organization more effective with stronger leadership, increased commitment of individual workers to fulfill organization-wide goals, and a better prepared, better trained, safer, diverse workforce.* (R. King, CAMI)

Technical Operations Hiring, Training & Certification (TOHTC): The TOHTC program evaluation working group met at CAMI June 6 & 7, 2006. The working group includes representatives from ATO-A Workforce Services (Rita Nelson, David Penn, & Audrey Prout, AJA-24), ATO-A Workforce Development (Larry Miller & Spencer Fitzgerald, AJA-33), the FAA Academy Airway Facilities Division (Dave Brown, AMA-400), and CAMI's Training & Organizational Research Laboratory (Dr. Dana Broach & Melanie Dennis, AAM-520).

The TOHTC program was implemented in October, 2004 as a means of reducing the time between hire and initial certification authority, and to enable assignment of certification workload to the new hire as quickly as possible. Under TOHTC, new hires into the Airway Transportation Systems Specialist (FG-2101) occupation report to the FAA Academy upon entry on duty rather than to their field facility. The new hires complete both non-equipment training (such as safety awareness) and communications equipment training while at the Academy. Communications equipment training includes theory of operations, laboratories, and 90% of the performance examination required for certification authority. Upon reporting to the hiring field facility, the new hire completes the remainder of the performance examination that focuses on local installation, configuration, and operations procedures, and is then given certification authority for that equipment. Before TOHTC, new hires reported to the field facility, and waited

for a training class, sometimes for extended periods of time. Generally, during that waiting period, the new hire could not be given workload associated with certification of systems. TOHTC is intended to reduce the waiting time and enable new hires to more quickly be assigned certification-related workload at field facilities. The FG-2101 job/task analysis data collected by CAMI in 2000-2003 for the occupation, an analysis of certifications held by specialists, and field systems/equipment were used to determine that communications would be the prototype for TOHTC. With over 30,000 VHF radios, communications equipment is the single most common component of the National Airspace System.

Dr. Broach and Ms. Dennis are providing consultation and analytic services to the TOHTC program through the evaluation working group. This meeting of the working group focused on the development and revision of surveys for TO new hires and field supervisors. The supervisor survey will be administered later this summer by AAM-520 using the recently awarded internet-based survey services contract. Data collected by survey of new hires and supervisors, along with objective data extracted from the Computerized Application Processing System (an on-line job application system for FG-2101s) and the Technical Operations Consolidated Management Information Reporting System, will be used by the working group to assess the TOHTC program relative to program objectives. If the evaluation finds a net positive benefit from TOHTC, the program may be expanded to the radar, navigational aids, automation, and environmental areas. *This activity supports the Administrator's Flight Plan Goal for Organizational Effectiveness, Objective 1: Make the organization more effective with stronger leadership, increased commitment of individual workers to fulfill organization-wide goals, and a better prepared, better trained, safer, diverse workforce.* (D. Broach, M. Dennis, CAMI)

En Route Automation Modernization (ERAM): On June 4-6, 2006, human factors researchers from the William J. Hughes Technical Center supported conduct of an Early User Involvement Event (EUIE) for the ERAM program. This EUIE focused on the support capabilities of ERAM such as test and training, and data reduction and analysis. The EUIE was sponsored by ATO-E and took place at the Lockheed Martin facilities in Rockville, MD. Together with human factors engineers from ATO-E, SAIC/TAC2, and Lockheed, participants observed field representatives exercise some of the support functions. They documented usability issues and provided recommendations for issue resolution. Capabilities that were not exercised will be described in upcoming briefings. Any potential usability issues raised during the briefings will also be documented. *This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 3: Increase on-time performance of scheduled carriers.* (T. Yuditsky, WJHTC)

Airspace Simulation: On June 6-8, 2006, researchers from the William J. Hughes Technical Center's Human Factors Team collaborated with members of the Laboratory Future Development Subteam, the Simulation and Analysis Subteam, and the Simulation Subteam, to conduct shakedown exercises for a "Big Airspace" simulation. Supervisory controllers from Jacksonville and Orlando, Florida, participated as subject matter experts. The primary purpose of the exercises was to determine whether airspace and procedures were appropriate. Some changes were identified in handoff altitudes, fix locations, holding patterns, and procedures for resectorization. In addition, changes were identified for traffic scenarios, such as adding more aircraft departing from satellite airports. Finally, the exercises identified problems with the

simulation system functionality which were corrected by laboratory programmers. Further shakedown exercises will be scheduled. *This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 3: Increase on-time performance of scheduled carriers.* (M. McAnulty, WJHTC)

Traffic Flow Management: On June 28, 2006, a research psychologist from the William J. Hughes Technical Center will participate in a meeting with representatives of the Traffic Flow Management User Team (TUT) and MITRE. MITRE will present future concepts for rerouting aircraft. The Technical Center will then work with TUT to evaluate the feasibility of the concepts and their potential impact on workload, potential for error, and situational awareness. The team's feedback will be used to update the concept and capability description and to serve as a basis for development of functional requirements. Aspects of the user interface will be addressed in the future. *This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 3: Increase on-time performance of scheduled carriers.* (T. Yuditsky, WJHTC)

More information on human factors research can be found at the FAA Human Factors (ATOP-R&D) web site: <http://www.hf.faa.gov>

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FAA (ATO-P R&D Human Factors)



June 24-28, 2006 – ASHRAE Annual Conference, Quebec, Canada <http://www.ashrae.org/>

June 26-29, 2006 - [General Aviation Technology Conference](#) , Hyatt Hotel, Wichita, Kansas,

June 27-29, 2006 – 4th Annual Cognitive Systems Workshop, Santa Fe, New Mexico
http://sandia.gov/cog.systems/cognitive_workshop/index.htm

June 27-29, 2006 – CGAR 2006 Conference, Embry-Riddle Aeronautical University, Prescott, AZ <http://www.cgar.org/default.asp>

June 28, 2006 – Toward a Safer Culture Seminar, FAA Headquarters, Wash, DC
glen.hewitt@faa.gov

July, 2006 - 26th International Congress of Applied Psychology, Athens, Greece
dgeorgas@dp.uoa.gr ,
http://www.erasmus.gr/dynamic/conventions.asp?conv_id=21r/dynamic/conventions.asp?conv_id=21

July 5-9, 2006 - International Organization of Women Pilots 2006 Convention, Washington Marriott, Wash, DC <http://www.ninety-nines.org/>

July 8-11, 2006 – ASA 2006 Annual Conference, Las Vegas, NV www.aviationsuppliers.org

July 10-14, 2006 – IEA 2006, 16th World Congress on Ergonomics, Maastricht, The Netherlands <http://www.iea2006.org/>

July 17, 2006 – 4th International Aviation Training Symposium, Oklahoma City, OK
<http://www.atca.org/home.asp>

July 17-23, 2006 – Farnborough International Air Show, London, UK
<http://www.farnborough.com/>

July 24-30, 2006 – EAA AirVenture, Oshkosh, WI <http://www.airventure.org/>

July 26-29, 2006 – CogSci 2006, Sheraton Vancouver Wall Centre, Vancouver, BC, Canada
<http://www.cogsci.rpi.edu/~rsun/cogsci2006/>

August 1, 2006 - The International Journal of Aviation Psychology, Special Issue on Air Traffic Control Human Factors, CALL FOR PAPERS. Please contact Jim Hitt at hitt_james@bah.com <mailto:hitt_james@bah.com> or Mike McAnulty at mike.mcanulty@faa.gov <<mailto:mike.mcanulty@faa.gov>> with any queries, or to submit papers.

August 2, 2006 – Annual ATCA Golf Outing, Waldorf, MD <http://www.atca.org/home.asp>

August 1-3, 2006 – 27th National Aerospace FOD Prevention Conference, Seattle, WA
www.nafpi.com

August 10-13, 2006 – American Psychological Association Annual Meeting, New Orleans, LA
<http://www.apa.org/convention05/future.html>

August 21-24, 2006 - AIAA Modeling and Simulation Technologies Conference and Exhibit. Keystone Resort and Conference Center, Keystone, CO
<http://www.aiaa.org/content.cfm?pageid=1>

August 21-24, 2006 - AIAA Guidance, Navigation, and Control Conference and Exhibit, Keystone Resort and Conference Center, Keystone, CO
<http://www.aiaa.org/content.cfm?pageid=1>

August 29-31, 2006 – General Aviation Technology Conference & Exhibition, Wichita Hyatt, Wichita, KS <http://www.sae.org/events/gat/>

September 6-8, 2006 - 11th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Renaissance Portsmouth, Portsmouth, VA,
<http://www.aiaa.org/content.cfm?pageid=1>

September 6-7, 2006 - FAA-ATA 18th Annual International Symposium for Human Factors in Maintenance and Ramp Safety, Orlando, FL. www.airlines.org

September 8-13, 2006 – 75th NASAO Convention, New Orleans, LA www.nasao.org

September 10-14, 2006 - 54th International Congress of Aviation and Space Medicine, Bangalore, India. A preliminary registration form may be found at <http://www.isam-india.org/conference44/newreg.php>.

September 12-14, 2006 – 23rd International Air Cargo Forum and Exposition, Calgary, Ontario, Canada <http://www.tiaca.org>

September 19-21, 2006 – Space 2006, San Jose, CA www.aiaa.org

September 20-22, 2006 – HCI-Aero 2006, Seattle, WA <http://www.eurisco.org/hci-aero2006>

Note: Submission Deadlines:

15th March 2006 - Full Research Papers

15 April 2006 - Industry Papers

15 April 2006 - Early Stage Research Papers

15 April 2006 - Panels, Workshops

15 April 2006 - Posters and Demos

September 26-27, 2006 – AIAA Aviation Technology, Integration and Operations Conference, Hyatt Regency, Wichita, KS <http://www.aiaa.org/content.cfm?pageid=1>

October 8-11, 2006 - IEEE International Conference on Systems, Man, and Cybernetics, The Grand Hotel, Taipei, Taiwan <http://ins.cn.nctu.edu.tw/smc2006/>
March 1, 2006: Deadline for submission of papers (full papers only)

October 15-19, 2006 – Digital Avionics Systems Conference, 25th DASC Network Centric Environment: The Impact on Avionics and Systems, Hilton Portland and Executive Tower, Portland, OR www.dasconline.org
February 19, 2006 – Deadline for submitting abstracts of 1000 words

October 15-20, 2006 – 2nd Annual Augmented Cognition International Conference, Hilton San Francisco, San Francisco, CA www.augmentedcognition.org

October 16-20, 2006 – Human Factors and Ergonomics Society Annual Meeting, San Francisco Hilton, San Francisco, CA <http://www.hfes.org/web/HFESMeetings/meetings.html>
Key Dates:

June 26 – Proceedings papers due

September 8, 2006 – Early registration deadline

October 16-19, 2006 – ATA 49th Annual Non-Destructive Testing Forum, Ft. Worth, TX
www.airlines.org

October 17-19, 2006 – NBAA 59th Annual Meeting and Convention, Orlando, FL
<http://web.nbaa.org/public/cs/amc/futuresites.php>

October 23-25, 2006 – 44th Annual SAFE Symposium, Reno Hilton Hotel, Reno, NV
<http://www.safeassociation.org/symposium.htm>

October 23-26, 2006 - DoD Maintenance Symposium & Exhibition, Reno Hilton, Reno, Nevada
<http://www.sae.org/events/conferences/aerospace/>

October 25-27, 2006 – Cargo Facts 2006, Miami, FL ashoemaker@cargofacts.com

October 29, 2006 – 51st Annual ATCA Conference & Exposition, Marriott Wardman Park, Wash., DC <http://www.atca.org/home.asp>

November 9-11, 2006 – AOPA Expo 2006, Palm Springs, CA
<http://www.aopa.org/expo/2005/virtual/>

November 13-14, 2006 ASTM F38 Unmanned Aircraft Systems Committee Workshop, Hyatt Regency, Atlanta, GA <http://www.astm.org/>

November 14-16, 2006 – Aerospace Testing Expo, Anaheim, CA www.aerospacetesting-expo.com

November 17-19, 2006 – NBAA Annual Meeting and Convention, Orlando, FL www.nbaa.org

January 8-11, 2007 - 45th AIAA Aerospace Sciences Meeting and Exhibit, Reno Hilton, Reno, NV <http://www.aiaa.org/content.cfm?pageid=1>

January 27-31, 2007 - ASHRAE Winter Meeting, Dallas, TX jyoung@ashrae.org, or www.ashrae.org.

February 13-15, 2007 – US Air Force T&E Days, Hilton San Destin Beach, Destin, FL
<http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=1474&viewcon=submit>

February 27, 2007 – CMAC 2007, Bangkok, Thailand <http://www.atca.org/home.asp>

March 3-10, 2007 – IEEE Aerospace Conference, Big Sky, Montana
<http://www.aiaa.org/content.cfm?pageid=1&show=All>

March 7-8, 2007 – Avionics 07 Expo XXI, [Amsterdam](http://www.avionics-event.com/avionics06/why_exhibit.html) http://www.avionics-event.com/avionics06/why_exhibit.html

March 9-11, 2007 - Human-Robot Interaction Conference 2007 Washington, DC:
<http://www.hri2007.org/>

April 17-23, 2007 – Sun ‘n Fun, Lakeland, FL <http://www.sun-n-fun.org/content/>

April 22-26, 2007 – 2007 International Symposium on Aviation Psychology, Dayton, OH
www.wright.edu/isap (NOTE: Call for Papers – Due July 10, 2006)

May 21-22, 2007 - ASTM F38 Unmanned Aircraft Systems Committee Workshop, Waterside Convention Center, Norfolk, VA <http://www.astm.org/>

June 23-27, 2007 – ASHRAE Annual Meeting, Long Beach, CA jyoung@ashrae.org,
www.ashrae.org

July 22-27, 2007 – 12th HCI International, Beijing, China <http://www.hcii2007.org/>

September 25-27, 2007 - NBAA 60th Annual Meeting and Convention, Atlanta, GA
<http://web.nbaa.org/public/cs/amc/futuresites.php>

October 1-5, 2007 – Human Factors and Ergonomics Society Annual Meeting, Baltimore Waterfront Marriott Hotel, Baltimore, MD
<http://www.hfes.org/web/HFESMeetings/meetings.html>

October 28, 2007 – 52nd Annual ATCA Conference & Exposition, Marriott Wardman Park, Wash., DC <http://www.atca.org/home.asp>

November 13-16, 2007 – DoD Maintenance Symposium and Exhibition, Rosen Shingle Creek, Orlando, FL <http://www.sae.org/events/conferences/aerospace/>

Note: Calendar events in Italics are new since the last Newsletter



Comments or questions regarding this newsletter?
Please contact Bill Berger at (334) 271-2928
or via e-mail at bill.ctr.berger@faa.gov

